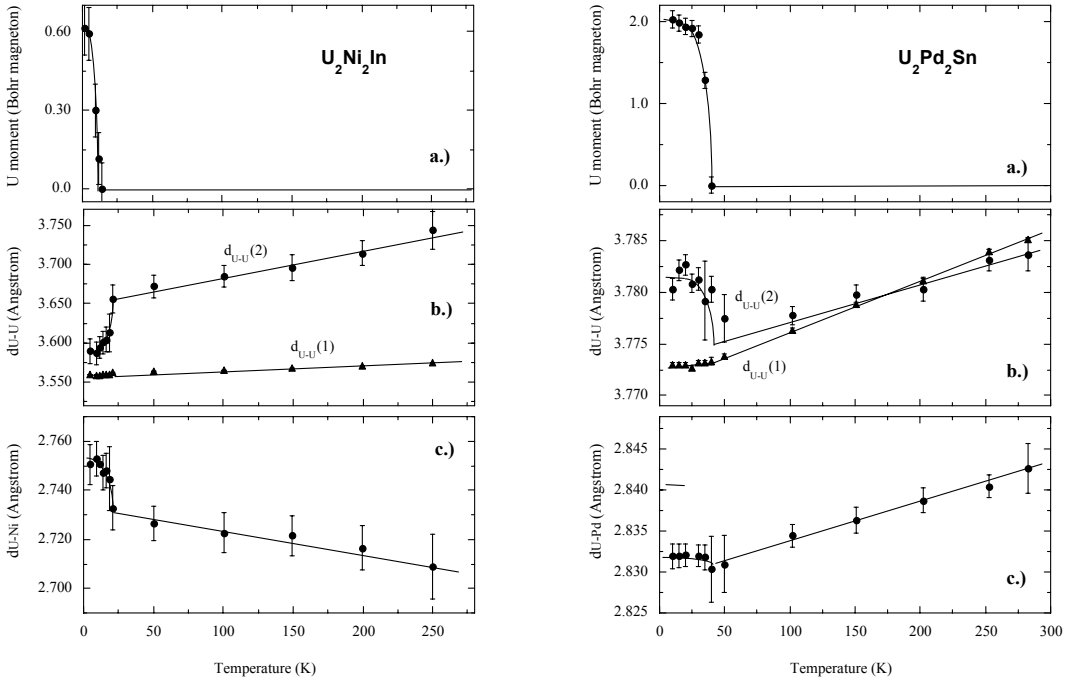
# NSF-CAREER: Effects of Pressure and Magnetic Field in Strongly-Correlated-Electron-Systems with Non-Collinear Magnetism

*PI: Heinz Nakotte, Physics Department, New Mexico State University*

The hybridization between the uranium *5f* electron states with the electronic states of the ligands determine the magnetic properties of uranium compounds. The so-called *5f*-ligand hybridization has long been believed to lead to two competing interactions: strong hybridization tends to 'wash out' the magnetic moments, but it also contributes to stronger inter-site exchange interactions (promoting a magnetic ground state).

In order to confirm this picture, we studied the temperature dependence of the structural and magnetic properties of two isostructural compounds, $U_2Ni_2In$ and $U_2Pd_2Sn$. Neutron diffraction confirmed the antiferromagnetic ground states in $U_2Pd_2Sn$ ($T_N = 40K$) and $U_2Ni_2In$ ($T_N = 14$ K) with non-collinear *5f* moments confined to the tetragonal basal plane. We found well-localized $U^{3+}$ moments in $U_2Pd_2Sn$, while the moments in $U_2Ni_2In$ are substantially reduced.




As a function of temperature, the shortest interatomic distance between uraniums and transition metals increases for $U_2Ni_2In$ (decrease of *5f*-ligand hybridization), while it decreases for $U_2Pd_2Sn$ (increase of 5f-ligand hybridization). **These results provide strong evidence that magnetic ordering in $U_2Pd_2Sn$ arises due to increased *5f-d* hybridization (promoting stronger exchange) while the reduced hybridization in $U_2Ni_2In$ allows for the formation of stable U magnetic moments.**

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In 2004, I helped to organize the first LANSCE Winter School on Magnetism and Neutron Scattering, held at the Los Alamos Neutron Science Center (LANL). The school convened on Friday, January 9, and concluded on Friday, January 16. Sunday was a free day, and included organized sight seeing and skiing in the local area.
It was attended by 30 students from U.S. institutions and one overseas institution. The school was seven days in length and included both lectures and an experimental portion that allowed students to do hands-on neutron experiments on magnetic systems using four of the Lujan Neutron Scattering Center instruments. Fourteen invited lecturers, who were world experts in specific fields of magnetism and neutron scattering, presented a total of 16 lectures.

The school was a tremendous success, as indicated by some of the written evaluations from the students, such as: *"The lectures were excellent, without exception"; "This school is very good and useful"; "I have been to other schools at Argonne and NIST. I think this school was more useful than the others"; "I had a wonderful experience that I could not have gotten anywhere else"; "This winter school has stimulated many ideas and potential experimental paths for my future scientific endeavors"; "Please continue this school for my colleagues"* and *"I thought the program was excellent. I was never bored"*.

Participants of the 2004 LANSCE Winter School listening to a lecture on *Determination of Magnetic Structures* by Heinz Nakotte